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The role of cerebrospinal fluid on chick cerebral cortex development

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Background

Cerebrospinal fluid (CSF) is mainly produced by the choroid plexuses within the ventricles of the brain. Hydrocephalus occurs when the normal flow of CSF is obstructed and fluid accumulates. The CSF circulates in a regular manner from the formation of the neural tube and enables it to carry chemical information. From the lateral ventricles CSF passes into the third ventricle and then moves on to the fourth ventricle. CSF leaves the ventricular system and enters the subarachnoid spaces. Ultimately CSF drains out of the subarachnoid space into the sagittal sinus via the arachnoid villi. CSF thus flows through the ventricular system passing over all regions of germinal activity. In previous studies on a rat model of hydrocephalus, the hydrocephalic Texas (HTx) rat, we showed that CSF has a potential role in the development of the cerebral cortex. In this study chick embryos were used to show the importance of CSF on brain development

Materials and Methods

In chick embryos the neural plate and neural tube appear 20 and 28 hours after incubation. The CSF starts to flow immediately after closure of the neural tube and in advance of the formation of the choroid plexuses. This CSF appears to be produced by the brain tissues. The chick embryos were cannulated in situ with a fine capillary tube early in development (days 3 and 5 after incubation) to drain CSF out of the ventricular system. After surgery the embryos were incubated for another 3 days. All the CSF drained and control embryos were collected, fixed in paraformaldehyde and coronal and sagittal 10 μm sections were cut on a microtome and stained with Methyl Green Pyronine and Hematoxyline-Eosin. The thickness of the cerebral cortex, germinal epithelium, intermediate zone and cortical plate and the area of the lateral ventricles were measured in both the control and CSF drained groups.

Results

Quantitative measurements have shown that the thickness of the cerebral cortex, germinal epithelium, intermediate zone and the cortical plate and the area of the lateral ventricles in CSF drained embryos were less than those in the control group at the same age. Statistical analysis showed that there is a significant increase in the area of the lateral ventricles and decrease in the thickness of the cerebral cortex, germinal epithelium, intermediate zone and cortical plate when compared to the control group.

Conclusion

This study provides confirmatory evidence that CSF is important for normal development of the cerebral cortex.